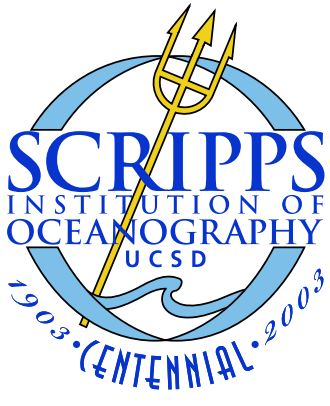
The Role of Eddies in the Thermohaline Circulation

Paola Cessi

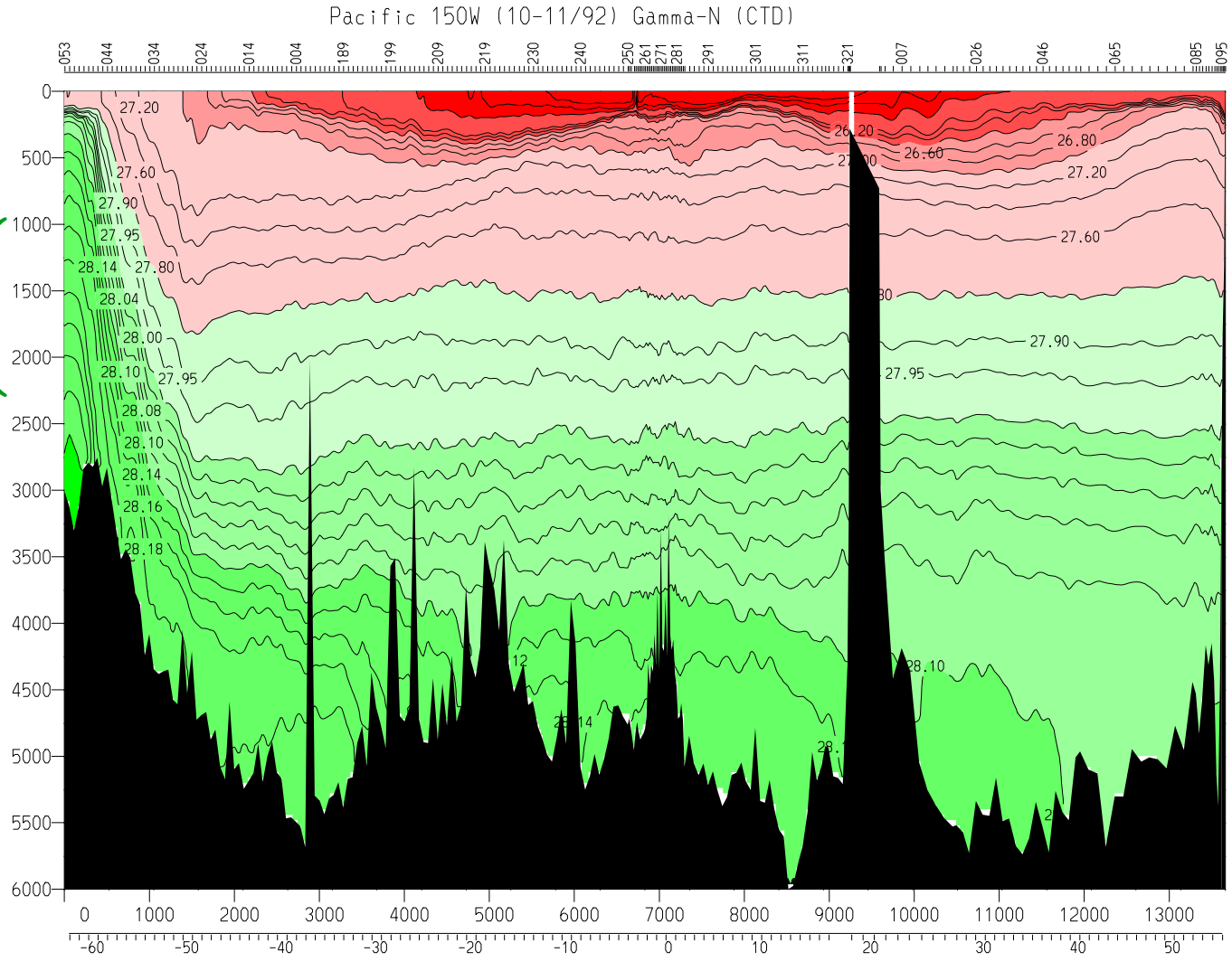
SIO – UCSD



WHAT MANTAINS THE ABYSSAL STRATIFICATION?

Wind-driven thermocline

Abyssal thermocline

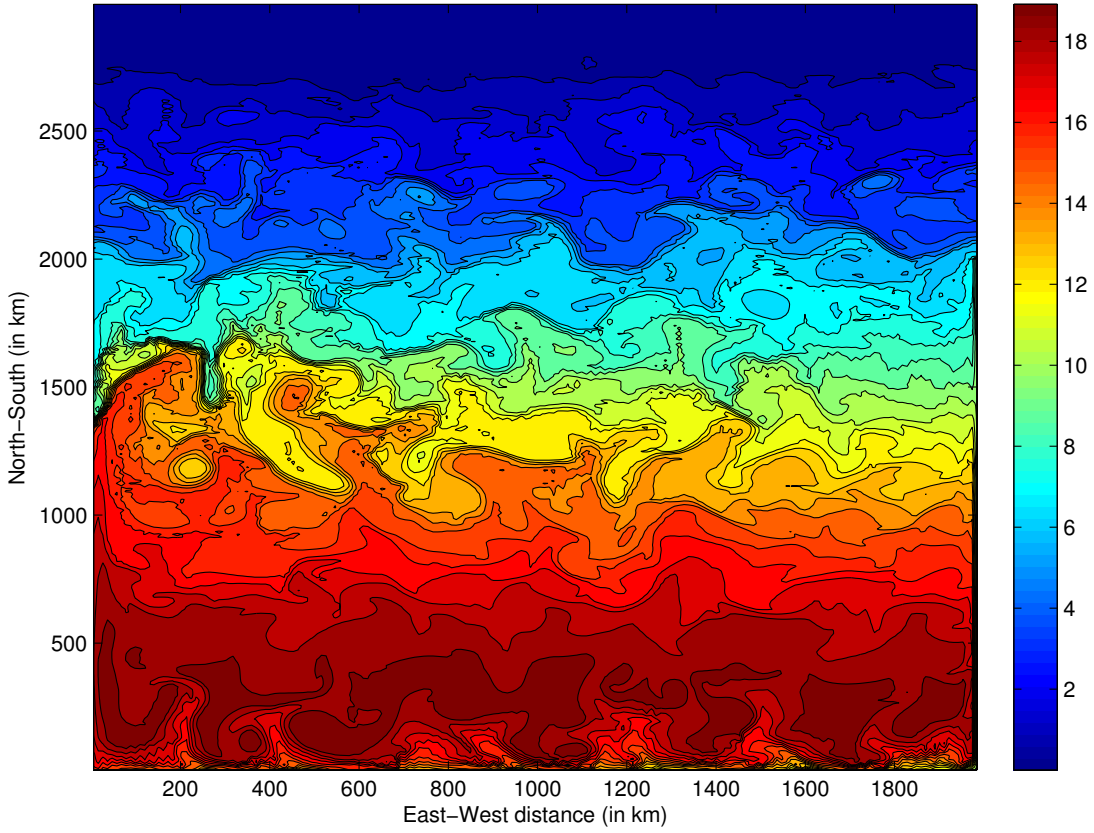


A deep energy source (mixing) raises the center of mass.

Otherwise, the abyss would be filled with the densest water.

WHAT BALANCES MIXING?

Classical theories assume that mixing is balanced by planetary-scale flow (the “conveyor belt”).
Much energy is at the mesoscale (10 - 100 km).



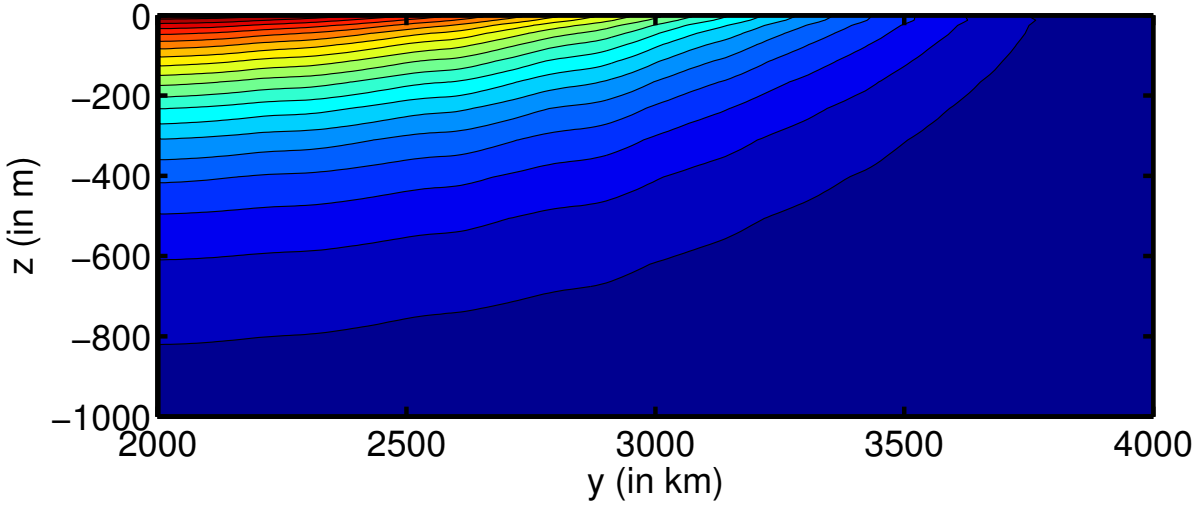
Sea-surface temperature from a simulation

Goal: understand the role of mesoscale in the heat balance.

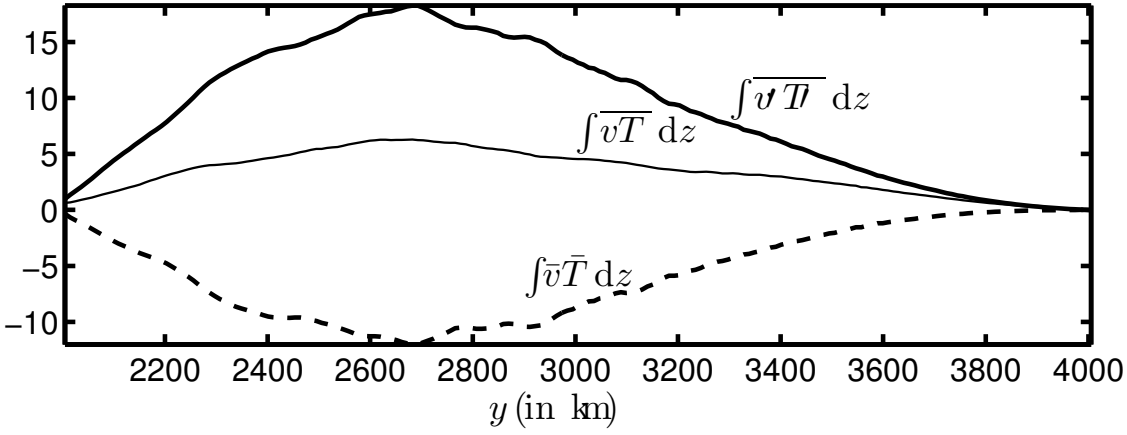
THE AVERAGE TEMPERATURE AND HEAT FLUX

$\bar{T}$ with westerly wind-stress, $\tau > 0$.

Mesoscale eddies stratify temperature to a depth $z = -h$.

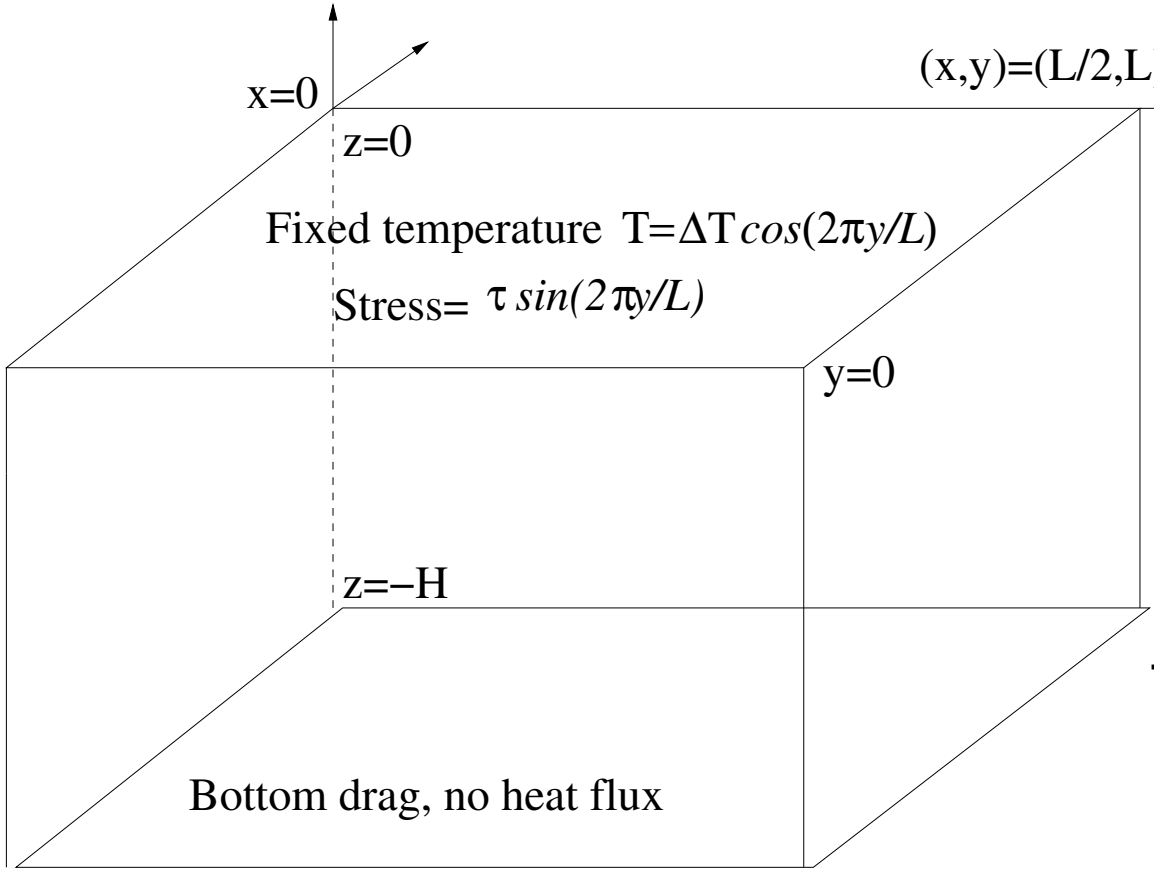


Mean and eddy heat fluxes almost cancel, leaving a small residual.



AN EDDY-RESOLVING MODEL

We consider flow driven by surface temperature in a semienclosed box $2000 \times 4000 \times 2$ km^3 or a channel.



Primitive equations,

Isotropic diffusion κ.

No convective adjustment.

β–plane.

Goal: to determine h and $\overline{vT}$ as a function of κ, τ, ΔT, ...

Produce parametrizations for use in climate models.

PARTICIPANTS

- Paola Cessi (PI)
- Jeff Polton (PostDoc)
- Ed Hill (MITgcm developer)

RESOURCES

The code is the MITgcm (Massachusetts Institute of Technology general circulation model).

It time-steps the discretized Navier-Stokes-Boussinesq equations using both explicit finite volume computations and an implicit 2-D inversion.

Already running on Ram, and compiled on Phoenix (thanks to Richard Mills!)

Not yet optimized.